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PLANNING STATUS REPORT

WATER RESOURCES APPRAISALS
FOR HYDROELECTRIC LICENSING

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UPPER ARKANSAS RIVER BASIN

**COLORADO, KANSAS
AND NEW MEXICO**

FEDERAL ENERGY REGULATORY COMMISSION
OFFICE OF ELECTRIC POWER REGULATION

Revised August 1980

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PLANNING STATUS REPORT

WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING

This is one of a series of revised Planning Status Reports for major river basins in the United States. The original reports, which were prepared several years ago, are being revised as part of a program of Water Resources Appraisals for Hydroelectric Licensing. The revised reports provide updated information on water resources for use by the Federal Energy Regulatory Commission and its staff when considering hydroelectric licensing and other work. The reports present data on water resource developments, existing and potential, and on water use by existing and projected steam-electric generating facilities. The reports also summarize past and current planning studies. The information presented in these reports was abstracted from available sources and involved no new analyses. The report is a staff effort which was not prepared for adoption or approval by the Commission, and does not commit or prejudge later Commission action.

FEDERAL ENERGY
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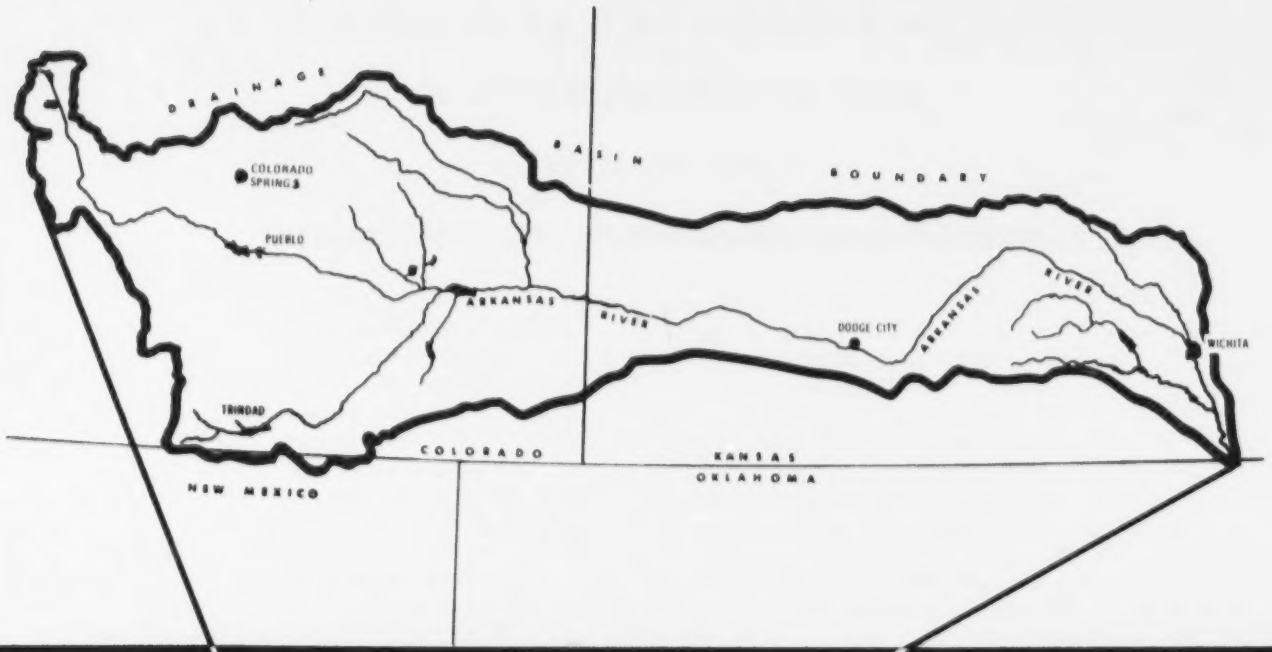
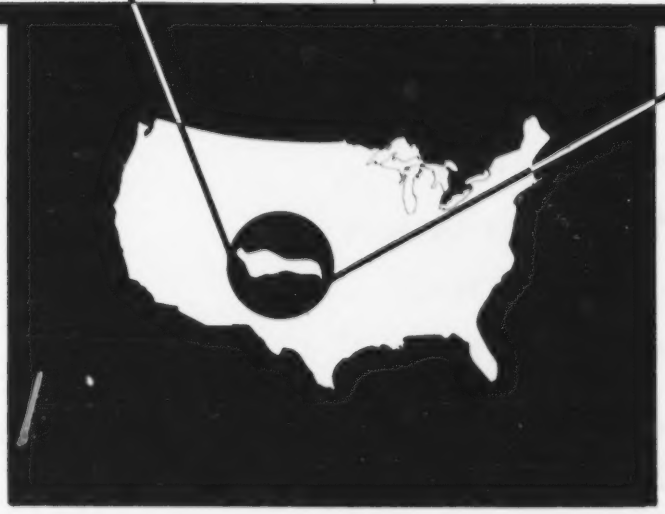
UPPER ARKANSAS RIVER BASIN





DESCRIPTION OF THE BASIN

The Upper Arkansas River basin is located in southeastern Colorado, western Kansas and the extreme northern part of New Mexico. The basin has a length of approximately 500 miles, a maximum width of 160 miles, and a drainage area of 43,736 square miles, and includes the watershed of the Arkansas River and its tributaries above the mouth of Walnut River in Kansas at river mile 696.1. Of the total area, 7,607 square miles are non-contributing to surface runoff because of numerous undefined stream courses in flat terrain where stream flow is dissipated through evaporation and percolation. A stream profile, figure 1, and a detailed basin map, figure 2, are included at the end of this report.

The Arkansas River rises on the eastern slope of the Rocky Mountains near Leadville, Colorado (river mile 1,444) at an elevation of over 10,000 feet. Runoff is collected from the slopes of nearby peaks that reach an elevation of over 14,000 feet. The river drops rapidly from its headwaters until it emerges from the mountainous area at river mile 1,332 where the elevation is about 5,300 feet. The river then follows an easterly course across the flat but undulating high plains of eastern Colorado and western Kansas to the lower end of the upper basin, near the Kansas-Oklahoma border. Principal tributary streams are the Purgatoire River, Big Sandy Creek, Pawnee River, Walnut Creek, and the Ninnescah River.

The climate in the western portion of the Upper Arkansas River basin is semi-arid to arid except for certain limited areas in the high mountains. Average precipitation in the western portion varies with the elevation of the terrain and ranges from 13.0 inches near Trinidad, Colorado, at elevation 5,746 to about 21.0 inches at North Lake, at elevation 8,800, about 30 miles west of Trinidad. At the higher altitudes, most of the fall and winter precipitation occurs as snow. In the eastern portion of the basin, the climate is sub-humid and precipitation averages about 30 inches annually. Average annual precipitation at Dodge City, Kansas, is about 20.5 inches and at Great Bend, Kansas, about 25.7 inches. The average annual observed regulated streamflow is 366 cubic feet per second at Granite, Colorado; 721 cubic feet per second at Canon City, Colorado; 684 cubic feet per second near Nepesta, Colorado; 210 cubic feet per second at Lamar, Colorado; 346 cubic feet per second at Syracuse, Kansas; 373 cubic feet per second at Great Bend, Kansas; 1,105 cubic feet per second at Wichita, Kansas; and 1,825 cubic feet per second at Arkansas City, Kansas. The natural flow of the stream is affected by transmountain diversions, storage reservoirs, groundwater withdrawals, irrigation diversion, and return flows. In 1945, a House Resolution granted the consent of Congress to the States of Colorado and Kansas to negotiate a compact for the division of the waters of the Arkansas River. The Arkansas River Compact was subsequently developed between the two States and became effective in 1949.

The average annual temperature for Trinidad, Colorado, and for Dodge City, Kansas, are 51 and 55 degrees Fahrenheit, respectively. Temperature extremes range from 110 to -30 degrees Fahrenheit.

The 1970 population of the Upper Arkansas River basin was approximately 1,087,600. Of the total population, 476,900 were in the State of Colorado and 610,700 in the State of Kansas. The population of the New Mexico portion

DESCRIPTION OF THE BASIN

was negligible. Farm population constituted less than 10 percent of the basin total. The 1970 population of major cities in the basin are: Wichita, Kansas 276,554; Colorado Springs, Colorado 135,060; Pueblo, Colorado 97,453; Hutchinson, Kansas 36,885; Great Bend, Kansas 16,133; Garden City, Kansas 14,708; Dodge City, Kansas 14,127; and McPherson, Kansas 10,851.

The Colorado portion of the basin is rich in natural resources. The mining and manufacturing of minerals contribute large sums of revenue to this area. Some of the minerals that are located in this part of the basin are beryllium, vanadium, gold, lead, iron, molybdenum, cadmium, manganese, silver, tin, tungsten, petroleum, uranium, and purite. The Kansas portion of the basin contains helium, petroleum, and natural gas fields which supply large quantities of gas for intrastate and interstate markets.

Farming practices vary over the basin with climatic and topographic conditions. In the mountains of the western basin, hay and other feed crops are raised for the sheep and cattle which provide the principal source of farm income. At the lower elevations of the basin, farming is more diversified. The most common crops are corn, small grains, alfalfa, sorghum, sugar beets, fruit, and vegetables. A mixed cropping pattern occurs in the irrigated area of the basin. Winter wheat and combine maize are principal cash income crops. Livestock, poultry, and other products are also of considerable importance.

Wichita, Kansas, is the largest industrial center in the basin. This area contains plants for the processing of crude petroleum, natural gas, foodstuffs, and other agricultural products. Wichita is a major aircraft center with several assembly plants. There are also plants engaged in the processing and manufacturing of foods and minerals throughout other parts of the basin.

A number of Interstate, U.S., State, and county highways traverse the basin and form an adequate network for vehicular transportation. Rail and airline transportation facilities supplement the highway system, interconnecting major cities in and adjacent to the basin.

Excellent hunting and fishing opportunities, primarily in the Colorado portion of the basin, provide recreational activity and related industries thus contributing to the economy of the basin.

EXISTING WATER RESOURCE DEVELOPMENTS

The reservoir development of the water resources of the Upper Arkansas River basin have been primarily for flood control with some hydroelectric development. Table 1 lists major flood control reservoirs in the Upper Arkansas River basin. Existing Corps of Engineers, Water and Power Resources Service (formerly the Bureau of Reclamation), and Soil Conservation Service flood control and local protection projects are described as follows.

EXISTING WATER RESOURCE DEVELOPMENTS

Table 1

Major Reservoirs
Upper Arkansas River Basin

Reservoir Name	Stream	Ownership 4/	Storage Capacity			
			Flood Control (ac-ft)	Conservation (ac-ft)	Dead (ac-ft)	Total (ac-ft)
Turquoise 1/ (Sugar Loaf Dam)	Lake Fork	WPRS	-	120,490	8,942	129,432
Twin Lakes 2/	Lake Creek	WPRS	-	93,192	72,987	166,179
Clear Creek	Clear Creek	Priv	-	1,116	7,808	8,924
Pueblo	Arkansas River	WPRS	93,000	300,000 3/	30,000	357,000
Cucharas	Cucharas River	Priv	-	21,000	-	40,210
Lake Henry	Offstream	Priv	-	6,300	-	-
Lake Meredith	Offstream	Priv	-	26,000	-	-
Adobe Creek	Adobe Creek	Priv	-	64,900	5,970	70,870
Horse Creek	Horse Creek	Priv	-	-	-	16,974
Trinidad	Purgatoire River	WPRS	51,000	20,000	43,500	114,500
Model	Chicosa Creek	Priv	-	6,200	14,150	20,350
Muddy Creek	Muddy Creek	SCS	-	-	-	27,600
John Martin	Arkansas River	USCE	261,100	347,600	10,000	618,700
Nee-So-Pah	Offstream	Priv	-	25,480	10,920	36,400
Nee Grande	Offstream	Priv	-	58,800	39,860	98,660
Nee Noshe	Offstream	Priv	-	73,360	21,490	94,850
Nee Skah	Offstream	Priv	-	25,720	9,940	35,660
Two Buttes	Two Buttes Creek	Priv	-	-	-	40,910
Cheney	Ninnescah River	WPRS	80,000	144,800	18,000	242,800

1/ Enlargement of original project - complete.
2/ Enlargement of original project - under construction.
3/ 66,000 ac-ft is joint use - flood control and conservation.
4/ WPRS - Water and Power Resources Service, formerly the U.S. Bureau of Reclamation; SCS - Soil Conservation Service; Priv - Privately owned; USCE - United States Army Corps of Engineers.

Corps of Engineer Projects

John Martin Reservoir project is located on the Arkansas River between the cities of Las Animas and Lamar, Colorado, about 58 miles upstream from the Colorado-Kansas State Line. It was completed and placed in operation in 1948. The Flood Control Act of 1965 authorized the Corps of Engineers to use but not exceed 10,000 acre-feet of flood control storage space to John Martin Reservoir for fish and wildlife and recreation purposes. The irrigation storage in the reservoir is emptied frequently and water-associated recreation is contingent upon acquisition of water rights by local interests for establishment and maintenance of a permanent pool. The State of Colorado is acquiring the necessary water rights to establish and maintain the pool. Since 1968, the Colorado Division of Wildlife has held a license for wildlife management control in over 17,918 acres of the project. It is presently negotiating for

additional acreage to expand its program. The draft, updated Master Plan has been completed and approved.

The Pinon Canon Dam is located on Pinon Canon Arroyo, just north of the city limits of Trinidad, Colorado. Its purpose is to protect the city from flash-floods originating on the 896-acre watershed of this small tributary of the Purgatoire River. The reservoir was completed in 1954.

The Trinidad Lake project was authorized by the Flood Control Act of 1958. This multi-purpose project is located on the Purgatoire River, a tributary of the Arkansas River, about 4 miles upstream from the city of Trinidad, Colorado. Construction started in 1968, and all major project features except the recreation facilities were completed by 1977. Recreation area work is tentatively set for completion in 1980.

Great Bend local protection project was authorized by the Flood Control Act of 1965. The city of Great Bend, Kansas, is vulnerable to flooding from Walnut Creek on the north and west and from the Arkansas River on the south. The plan of improvement consists of a gated diversion dam on Walnut Creek to divert flood flows through a channel and levee system west of town and into the Arkansas River. On November 2, 1976, a bond issue to finance non-Federal costs was rejected. In May 1977, a bond issue for non-Federal costs was again rejected. The city of Great Bend, Kansas, was unable to provide the requirements for local cooperation, and as a result, the project has been reclassified from the active to the inactive category effective June 3, 1977. The city of Great Bend, Kansas, was notified on that date, that failure to provide local assurances within 5 years would result in the automatic deauthorization of the project.

Water and Power Resources Service (WPRS) Projects

Wichita Project-Cheney Division is located on the North Fork of the Ninnescah River about 30 miles west of the city of Wichita, Kansas. The Cheney Reservoir provides municipal and industrial water supply, flood control, fish and wildlife, and recreation benefits. Construction of the dam was completed in 1965. The city of Wichita constructed a pipeline from the dam to Wichita, and water was made available in 1965. Wichita assumed operation of the dam and reservoir on October 1, 1965.

Municipal and industrial water supplied from the reservoir to the city in 1977 totaled 16,085 acre-feet. The Kansas State Park and Resource Authority administers operation and maintenance of recreation facilities; and the Kansas Forestry, Fish and Game Commission is responsible for wildlife conservation and management.

The Pueblo Dam and Reservoir, located 6 miles upstream of Pueblo, Colorado, is part of the Fryingpan-Arkansas project and was constructed for flood control, hydroelectric power, water supply, and irrigation. The dam was completed in August 1975 and is the terminal reservoir of the Fryingpan-Arkansas project. The reservoir has a total storage capacity of 357,000 acre-feet, of which 93,000 acre-feet is allocated to flood control. The Corps of Engineers is responsible for prescribing regulations for the use of the flood control storage.

EXISTING WATER RESOURCE DEVELOPMENTS

Sugar Loaf Dam-Turquoise Lake and Twin Lakes projects, part of the WPRS's Fryingpan-Arkansas project, represent enlargements of existing developments. The reservoirs serve to store and release water as required for power generation, irrigation, and other downstream uses. Prior water rights exist for 17,416 acre-feet in Turquoise Lake and 54,452 acre-feet in Twin Lakes. Twin Lakes serves as the afterbay of the Mt. Elbert pumped storage project.

Soil Conservation Service (SCS)

The SCS has some 42 authorized projects within the basin. These projects are generally small scale watershed protection and flood prevention projects. They normally include a number of small, strategically placed dams, as opposed to one large structure.

Existing and Under Construction Hydroelectric Power

Hydroelectric projects in the Upper Arkansas River basin, either existing or under construction, are listed in table 2.

Table 2

Existing Hydroelectric Developments
Upper Arkansas River Basin

Project	Stream	State	Owner Class	Owner 2/	FERC Project No.	Installed Capacity (kW)	Initial Operation	Gross Head (ft)
Salida No. 1	Arkansas River	Colo.	U	PSCO	2275	750	1905	437
Salida No. 2	Arkansas River	Colo.	U	PSCO	2275	560	1908	342
Manitou Springs	Ruxton Creek	Colo.	P	COSP	768	5,000	1905	2,421
Ruxton Park	Ruxton Creek	Colo.	P	COSP	768	1,000	1925	1,165
Mt. Elbert	Lake Creek	Colo.	F	WPRS	-	200,000	1/	464

1/ *The 200-MW Mt. Elbert pumped storage powerplant in Colorado has an expected in-service date of July 1981 for the first 100-MW unit and August 1983 for the second 100-MW unit.*

2/ *U-privately-owned utility; P-non-Federal publicly-owned utility; F-Federal; PSCO-Public Service Company of Colorado; WPRS-Water and Power Resources Service, formerly the U.S. Bureau of Reclamation; COSP-City of Colorado Springs.*

Ruxton Park and Manitou Springs (Project No. 768) are located on Ruxton Creek at river mile 7 above Fountain Creek, near Colorado Springs, Colorado. The flow at the Ruxton project is controlled by eight upstream reservoirs as the Ruxton project does not include storage. Water for generation is conveyed to the project through a pipeline leading from Lake Morain. The project, completed in 1925, has a gross static head of 1,165 feet (average head 1,114 feet), a generating capacity of 1,000 kilowatts, and an average annual generation of 1.5 million kilowatt-hours. Water for generation at Manitou Springs is piped from the upstream Ruxton Park plant and also from Crystal Creek and South Catamount Reservoir. Manitou Springs, completed in 1905,

has a gross static head of 2,421 feet, a generating capacity of 5,000 kilowatts, and an average annual generation of 16.4 million kilowatt-hours. Both powerplants are operated in conjunction with Colorado Springs' municipal water demand.

Salida Nos. 1 and 2 (Project No. 2275) are operated by the Public Service Company of Colorado. Water used to generate power at the No. 1 plant is conveyed by a gravity pipeline that carries water from the Garfield Diversion Works, a concrete gravity dam on the South Arkansas River, to the Fooses Forebay, an earthfill dam on the South Fooses Creek. This dam is connected to the hydroelectric plant by an 12,886-foot long pipeline. Salida No. 1 has a capacity of 750 kilowatts, a gross static head of 437 feet, and an average annual generation of 4.1 million kilowatt-hours. The plant has been in operation since 1905. The Salida No. 2 plant is connected to the Forebay Pond by a 11,688-foot long pipeline. The capacity of this plant is 560 kilowatts, the gross static head is 342 feet, and the average annual generation is 3.9 million kilowatt-hours. Power generation from the plant began in 1908.

The Mt. Elbert pumped storage hydroelectric facility is currently under construction with an initial 100,000-kilowatt capacity completed. An additional 100,000 kilowatts are currently under construction. The plant, located on the north shore of Twin Lakes, Colorado, about 13 miles south of Leadville, is being constructed by the U.S. Water and Power Resources Service as one of the principal features of the Fryingpan-Arkansas project (FAP). Water for the facility is diverted from the western slope of the Rocky Mountains to the Upper Arkansas River basin. Sugar Loaf Dam, Turquoise Lake, and the Twin Lakes projects serve to store and release water as required for power generation, irrigation, and other downstream uses. Twin Lakes serves as the afterbay for the Mt. Elbert plant. This water in addition to the flow of the Arkansas above the project is routed through the reversible units. The plant operates on a 10 AM to 8 PM daily cycle with pumping during off peak hours and weekends.

The Fryingpan-Arkansas project plan consists of facilities designed primarily to divert water from the Western Slope of the Rocky Mountains to the water-short areas on the Eastern Slope. Major facilities consist of 6 storage dams and reservoirs, 16 diversion structures, and 9 tunnels. When completed, scheduled for 1985, the project will make possible an average annual diversion of 69,200 acre-feet of water.

Municipal and Industrial

Municipal and industrial water supplies are derived from three sources: streamflow, groundwater, and water supply, and also transmountain diversions from other basins. The Fryingpan-Arkansas project should help areas along the Arkansas River basin meet their present and future water needs. The existing steam-electric generating facilities are listed in table 3. In 1975, there were 15 fossil-fueled plants located in the Upper Arkansas River basin with a total generating capacity of 2,921,000 kilowatts. The generation for 1975 was approximately 11,215 million kilowatt-hours. Three plants use once-through cooling, and the others use wet cooling towers. Nine of the plants obtain their cooling water from wells. The estimated 1975 cooling water use was 66 million gallons per day withdrawn and 17 million gallons per day consumed.

EXISTING WATER RESOURCE DEVELOPMENTS

Table 3

Existing Steam-Electric Plants
Upper Arkansas River Basin

Plant Name	Owner 2/	State	Capacity (kW)	1975 Generation (million kWh)	Type Cooling 1/	Cooling Water Withdrawn (mgd)3/	Cooling Water Consumed (mgd)3/	Cooling Water Source
W. N. Clark	CETU	Colo.	44,000	146	OT	15	0	Arkansas River
Martin Drake	COSP	Colo.	282,000	1,215	WT	3	2	City of Colorado Spr.
George Birdsall	COSP	Colo.	63,000	152	WT	0	0	City of Colorado Spr.
Lamar	LAPL	Colo.	35,000	74	OT 4/	8	0	Wells
Pueblo	CETU	Colo.	32,000	143	OT	15	0	Arkansas River
Comancne	PSCO	Colo.	779,000	1,909	WT	5	3	Arkansas River
Arthur Mullergren	CETU	Kan.	119,000	623	WT	2	1	Wells
Judson Large	CETU	Kan.	180,000	550	WT	2	1	Wells
Garden City	SUNC	Kan.	90,000	246	WT	0	0	Wells
Hutchinson	KAPL	Kan.	257,000	1,150	WT	3	2	Wells
Murray Gill	KAGE	Kan.	348,000	1,668	WT	5	3	Wells
Ripley	KAGE	Kan.	87,000	181	WT	0	0	Wells
Gordon Evans	KAGE	Kan.	539,000	2,973	WT	8	5	Wells
McPherson	MCPH	Kan.	32,000	132	WT	0	0	Wells
Wellington	WELL	Kan.	34,000	53	WT	0	0	City of Wellington
Totals			2,921,000	11,215		66	17	

1/ OT-once-through cooling; WT-wet tower cooling.
2/ CETU-Central Telephone & Utilities Corporation; COSP-City of Colorado Springs; LAPL-City of Lamar, Colorado; PSCO-Public Service Company of Colorado; SUNC-Sunflower Electric Cooperative; KAPL-Kansas Power & Light Company; KAGE-Kansas Gas & Electric Company; MCPH-City of McPherson, Kansas; WELL-City of Wellington, Kansas.
3/ MGD - million gallons per day.
4/ Well water pumped through condenser and returned to river.

Main stem flows of the Arkansas River in Kansas and Colorado cannot be used for most purposes without extensive treatment because of chloride contamination from natural sources. However, some of the tributary flows in the basin are suitable for domestic and industrial use without treatment.

The amount of water available for irrigation varies from year to year but is seldom adequate for maximum crop production. In order to obtain beneficial use of available flows, local interests have constructed small off-stream storage reservoirs, developed supplemental groundwater supplies, and utilized return irrigation flows. Shortages are expected to be reduced as a result of the Fryingpan-Arkansas interbasin water transfer project by the Water and Power Resources Service.

STATUS OF HYDROELECTRIC LICENSING

Four hydroelectric power facilities, as shown in table 4, are licensed by the Federal Energy Regulatory Commission in the Upper Arkansas River basin. These are the Salida Nos. 1 and 2 facilities, Project No. 2275, operated by the Public

STATUS OF HYDROELECTRIC LICENSING

Service Commission of Colorado, and the Ruxton Park and Manitou Springs facilities, Project No. 768, operated by the City of Colorado Springs. Ruxton Park and Manitou Springs were originally licensed August 2, 1927; this license expired on August 1, 1977. The projects are currently operated under annual licenses while a minor license is being processed. An application for relicense was filed on February 27, 1978. Section 30 of the Federal Power Act, as amended by Public Law 95-617, gives the FERC discretion to grant an exemption from licensing or any other requirements of part I of the Act for hydroelectric utilities which utilize only man-made conduits operated primarily for distribution of water rather than the generation of electricity. An application for exemption from licensing conduit hydro facilities was filed on January 11, 1980.

A minor license for the Salida Nos. 1 and 2 plants, Project No. 2275, was reissued March 5, 1965, and expires December 31, 1993. The plants are operated by the Public Service Company of Colorado.

Table 4

Status of Hydroelectric Licensing
Upper Arkansas River Basin

Project Name	FERC Project No.	Type of License	Status	Licensed Expiration Date
Salida Nos. 1 and 2	2275	minor	outstanding	December 31, 1993
Ruxton Park & Manitou Springs	768	minor	outstanding	August 1, 1977 1/

1/ Relicense application filed February 27, 1978.

WATER RESOURCES PLANNING

Prior Studies and Reports

A report by the Corps of Engineers published as House Document No. 308, 74th Congress, 1st Session, 1935, gave consideration to flood control, navigation, water power, irrigation, and other water uses of the main stem of the Arkansas River from Hutchinson, Kansas, to the mouth of the Walnut River. No construction was recommended in the report.

Senate Document 13, 85th Congress, 1st Session, the Arkansas-White-Red River Basins report was published in 1955 by the Arkansas-White-Red Inter-Agency Committee. The report, discussing the conservation and development of the water and land resources of the basin, was prepared by Federal and State agencies under the authorization of section 205 of the Flood Control Act of 1950. The Upper Arkansas River basin is discussed in part II, section 2, Volume A. Some of the proposals from that report have been constructed, and are listed in this report.

WATER RESOURCES PLANNING

A project planning report for the Fryingpan-Arkansas project, from the Bureau of Reclamation (now, the Water and Power Resources Service) was published as House Document No. 187, 83rd Congress, 1st Session, 1953. Based on this report, the project was authorized by Public Law 87-590, 87th Congress, 2nd Session, August 16, 1962, and several parts of the project are presently under construction. The multi-purpose project would provide supplemental water supplies for irrigation, municipal and industrial uses, hydroelectric power, flood and sediment control, and recreation. It was proposed that annual west-slope diversions will be utilized in addition to the flows of the Arkansas River for power production at six authorized powerplants downstream, at such time as feasibility of construction of the powerplants is established. These plants are listed in table 5. Several features of the Fryingpan-Arkansas project are presently under construction as previously noted.

The proposal for the Cheney Division of the Wichita Project (Kansas) by the Water and Power Resources Service was published as House and Senate Resolutions 4606 and 1092, respectively. The Cheney Reservoir was authorized by Public Law 86-787, 86th Congress, 1960, for the purposes of municipal water supply, flood control, recreation, and fish and wildlife. The project was completed in 1965.

Studies by the Corps of Engineers of the Purgatoire (Picket-Wire) River, Colorado, were published as House Document No. 387, 78th Congress, 2nd Session, 1945, and House Document No. 325, 84th Congress, 2nd Session, 1956. The Corps of Engineers recommended the construction and operation of the Trinidad Reservoir for flood control and irrigation but not for hydroelectric power which was not economically feasible at the time. The Federal Power Commission, by letters dated July 13, 1954, and May 13, 1963, concurred that hydroelectric power facilities could be installed in the future, without modification of the dam, if they become economically justified. The Trinidad project was authorized by the Flood Control Act of 1958 in accordance with recommendations contained in House Document No. 325 and was completed, excluding recreation facilities, in 1978.

The Bureau of Reclamation has completed the Western Energy Expansion Study for the 17 western states which include Kansas and Colorado. The study, completed in FY (fiscal year) 1977, inventory and compares opportunities to increase the availability of energy capacity and generation through water management and development. Consideration was given to using Federal project's water to cool thermal powerplants, revision of present operations at conventional and pumped storage hydroelectric plants, the enlargement of present facilities, the exploration for new installations, and the overall reorganization and modernization of facilities to increase power output and reduce waste and duplication. Three potential pumped storage sites in the Upper Arkansas River basin were selected for studies in the report. Recommended for site specific studies was the Phantom Canyon pumped storage plant in western Upper Arkansas River basin in Colorado. This project is discussed in the potential hydroelectric section of this report.

The Water and Power Resources Service (WPRS) periodically reappraises the individual features of the Fryingpan-Arkansas project. This includes the re-evaluation of potential hydroelectric power projects.

The Bureau of Reclamation initiated a reconnaissance study of the Sangre de Cristo project in 1965. That project would develop the power potential of the Arkansas River between the Salida powerplant of the Fryingpan-Arkansas project and Canon City, Colorado. Development of the project was determined to be infeasible at the time of the study.

The SCS also has completed and distributed a cooperative river basin survey titled "The Arkansas River Basin in Kansas." The report was completed by the Kansas Water Resources Board and the U.S. Department of Agriculture. The survey was authorized and funded in FY 1966. The report covers the portion of Kansas drained by the Arkansas River and its tributaries. The study provides data to the Kansas Water Resources Board for use in its Water Resources Plan studies. The study provides a plan for the basin's upstream water and land resources.

Current and Future Studies

Under authority of section 208 of the Flood Control Act of 1965, approved October 27, 1965, (Public Law 89-298, 89th Congress, 1st Session) and in compliance with resolutions by several Congressional committees, the Corps of Engineers published a review survey report for flood control and allied purposes on the Arkansas River and tributaries above the John Martin Dam. The survey report, covering the Arkansas River from its headwaters to John Martin Reservoir in Colorado, was approved and authorized for preconstruction planning in March 1974. The plan of improvement consists of the Arkansas River Floodway, Brewster to Florence; a 7-mile test reach of channel improvement upstream of La Junta; local protection projects at Florence, Portland, Pueblo, and La Junta; the Fountain Lake project, a multi-purpose project to be located on Fountain Creek upstream from Pueblo; and an environmental study of the alternatives for channelization of the Arkansas River from Pueblo to Las Animas, exclusive of a 7-mile test reach. The Phase I General Design Memorandum for Fountain Creek was completed in 1979.

Several Corps of Engineers' project investigations are being carried out for the Arkansas River basin above Keystone Dam. Those which affect the Upper Arkansas River basin (UARB) are discussed as follows.

By authority of resolution adopted September 30, 1942, by the Committee on Commerce, U.S. Senate; resolution adopted July 2, 1943, by the Committee on Flood Control, U.S. House of Representatives; resolution adopted June 10, 1958, by the Committee on Public Works, U.S. Senate; and section 208 of the Flood Control Act of 1965. (Public Law 89-298); the Corps of Engineers is making an investigation of Arkansas River and tributaries from Great Bend, Kansas, to John Martin Dam, Colorado, to consider flood control and related problems and the feasibility of additional improvements for water resources development.

"The Arkansas River, Great Bend, Kansas, to Tulsa, Oklahoma, Study" developed an integrated plan for flood control and related improvements in the Mid-Arkansas basin. Included in the study was the determination of the economic feasibility of the extension of navigation from the Arkansas River Waterway into Kansas, and the inventory of the water resources problems, needs and potential projects.

WATER RESOURCES PLANNING

Public hearings were held in Wichita, Kansas, in 1965 and 1966 to initiate survey report studies. A basic environmental inventory of the basin is now completed. Preliminary investigations of the economic feasibility of extending navigation into Kansas from the McClellan-Kerr Arkansas River navigation system were suspended after it was found to be uneconomical. A small dam watershed flood control project for the Little Arkansas River basin, 10 miles west of Newton, Kansas, and 7 large flood control, water supply, and recreation lake projects in Kansas were identified in the UARB. The study is scheduled for completion in 1984. Scope studies of the Chisholm Creek, Wichita, Kansas (Park City area), Arkansas River and Bull Creek, Nickerson, Kansas, and Little Arkansas River and Sand Creek, Sedgwich, Kansas, are also being considered and are awaiting funds to continue definite project report studies.

Another Corps of Engineers' project investigation is the survey-scope study for the Arkansas River and tributaries from John Martin Dam, Colorado, downstream to and including Walnut Creek which is 4-1/2 miles below Great Bend, Kansas. The investigation is to determine if improvements in the interest of flood control and allied purposes are advisable at the present time. An interim report recommended a main stem dam and lake near Kendall, Kansas, and a local protection project at Lamar, Colorado, was submitted to the Board of Engineers for Rivers and Harbors in 1974. In January 1975, the Board returned the report for expansion in accordance with principals and standards.

Recent Corps of Engineers' studies indicate both the Lamar and Kendall Lake projects can no longer be justified economically under current interest rates and construction costs; therefore, work has been suspended. Current study efforts are directed toward 14 potential local protection projects on the main stem Arkansas. Studies in the Bear Creek basin will be initiated in FY 1980 and will be part of the total feasibility study.

The Soil Conservation Service (SCS) presently has several Resource Conservation Projects underway in the Upper Arkansas River basin (UARB). The purpose of these projects is to expand the economic opportunities for the people of the area by developing and carrying out a plan of action for the conservation, improvement, development, and wise use of all natural and human resources.

The projects are identified as follows: East Central Colorado watershed protection encompassing Cheyenne, Elbert, El Paso, and Lincoln Counties in the UARB; the Sangre de Cristo project encompassing Custer, Fremont, Huerford, Las Animas, Pueblo, Lake, and Chaffee Counties in the western Colorado portion of the UARB, planning in progress; and the Sunflower, Kansas project encompassing Kiowa, Pratt, Kingman, and Sumner Counties in the UARB, which have planning completed with some construction in progress.

The Water and Power Resources Service, in cooperation with the State of Kansas Water Resources Board, is investigating the long-range water supply problems of the State of Kansas. This study is authorized by the Water Resources Planning Act of 1965 (Public Law 89-80, 89th Congress) and by the Federal Reclamation Laws (Act of June 17, 1902, Statute 388, and subsequent amendments). Amendments to the basic legislation in 1967 provided for State participation in the study.

WATER RESOURCES PLANNING

This Kansas State Water Plan comprises a comprehensive appraisal type investigation of the State of Kansas. The Phase I report titled "Long-Range Water Supply Problems" was published by the USBR on January, 1975. The Phase II statewide appraisal was initiated in FY 1975. This phase studies the problems and needs identified in Phase I, and evaluates their feasibilities on the basis of physical and economic considerations. Overall plans will be developed to attain the most efficient and economic distribution of water supplies in Kansas. The study will recognize the correlation of inter-basin water supplies and potential land developments and the possibilities for further development with particular emphasis on groundwater.

The U.S. Army Corps of Engineers is currently conducting a detailed assessment of the Nation's hydroelectric resources as part of the National Hydroelectric Power Study authorized by section 167 of the Water Resources Development Act of 1976 (Public Law 94-587). The study is designed to provide a current and comprehensive estimate of the potential for incremental or new generation at existing dams and other water resource projects, as well as for undeveloped sites in the United States.

The Federal Energy Regulatory Commission's Office of Electric Power Regulation, Division of River Basins, is preparing a river and site coding system including mapping for hydropower resources assessment. The system has been designed for use in maintaining an updated computer file, with reference maps, of developed and undeveloped hydropower in the United States. Publication of the assessment and reference maps is expected near the end of 1980.

POTENTIAL WATER RESOURCE DEVELOPMENTS

Potential Hydroelectric Development

Several potential reservoir projects have been proposed as part of the authorized Fryingpan-Arkansas project and the unauthorized Sangre de Cristo project. These, along with other potential hydroelectric developments, are located on figure 2 and listed in table 5.

The Mt. Elbert hydroelectric facility (existing) and the Otero plant are the only "survivors" of the six hydroelectric plants planned as part of the Fryingpan-Arkansas Project (FAP). The Wapaco, Princeton, Pancho, and Salida projects are not considered economically feasible for the foreseeable future by the Water and Power Resources Service. The Otero project is tentatively scheduled for construction in 1983. Its powerplant receives its water from the upstream Twin Lakes Reservoir via the Otero Canal. Twin Lakes Reservoir is the afterbay of the Mt. Elbert plant. The Otero plant is authorized for an ultimate installed capacity of 11,000 kilowatts at a gross static head of 270 feet.

The Water and Power Resources Service's once proposed Sangre de Cristo Power project consisted of four run-of-the-river powerplants located on a presently unconstructed canal adjacent to the Arkansas River, extending from Salida to Canon City, Colorado, and about 50 miles in length. In descending order,

Table 5

Potential Hydroelectric Projects
Upper Arkansas River Basin

Project	Stream	Gross Head (ft)	Installed Capacity (kW)	Estimated Annual Energy (MWh)	Storage Capacity Usable for Power (ac-ft)	Storage Capacity Total (ac-ft)
Fryingpan-Arkansas Project						
Otero	Canal	270	11,000	51,000	93,000	-
Wapaco	Canal 1/	495	20,600	117,700	Pondage	-
Princeton	Canal 1/	281	14,400	63,700	Pondage	-
Pancho	Canal 1/	268	18,500	64,300	Pondage	-
Salida 2/	Canal 1/	405	28,000	95,000	Pondage	-
Totals			92,500	391,700		
Sangre de Cristo Project						
Wellsville	Canal 1/	410	41,500	144,000	0	0
Badger	Canal 1/	590	60,000	204,000	0	0
Grape Creek	Canal 1/	665	68,000	252,000	0	0
Canon City	Canal 1/	125	7,200	43,000	0	0
Totals			176,700	643,000		

1/ Canal (segment) presently unconstructed.
2/ This potential project is upstream from the previously identified existing Salida Nos. 1 and 2 projects.

these projects are the Wellsville, Badger, Grape Creek, and Canon City. The potential installed capacity at these sites is a total of 176,700 kilowatts. Grape Creek Reservoir, proposed location above Canon City, would provide 750 acre-feet capacity for equalizing power flows before release to the Arkansas River. The Sangre de Cristo is dependent on the authorized FAP for its water supply. Water would be diverted into the project from the afterbay of the proposed Salida plant. The Sangre de Cristo project is currently not being actively considered by the WPRS. Development of this project is dependent on the findings in future WPRS economic studies.

Previous staff investigations of the possibility of developing hydroelectric power at the Pueblo, Trinidad, and John Martin projects have indicated that conflicting water uses make the development of hydroelectric power uneconomical under the projects current operation schedules. However, as stated in this report's Current and Future Studies section, the Corps of Engineers' National Hydropower Study may identify potential for new generation at existing dams and other water resource projects in the basin.

POTENTIAL WATER RESOURCE DEVELOPMENTS

Pumped Storage Development

The mountainous nature of the western Upper Arkansas River basin lends to numerous potential pumped storage sites. The Water and Power Resources Service's "Western Energy Expansion Study" has studied three potential pumped storage developments in the Upper Arkansas River basin. Of the three sites, only one, the Phantom Canyon pumped storage plant in Colorado, was recommended for additional studies. This potential development would be located about 33 miles northwest of Pueblo, Colorado. The lower reservoir would be formed by damming Eightmile Creek, while the upper reservoir would be 1,700 feet above on the southern slope of Cooper Mountain. A 2,500-megawatt powerplant, waterways, and about 50 miles of 230-kilovolt transmission lines would be included. The project would serve the peaking power needs of the southern end of the east slope Colorado load centers. The project would generate 1,000 gigawatt-hours of energy annually and would require 1,500 gigawatt-hours for pumping.

Potential Flood Control Developments

A study of the Fountain Lake storage reservoir project (for flood control) near Pueblo, Colorado, was included by the Corps of Engineers in the survey report of the Arkansas River from its headwaters to the John Martin Reservoir and has been approved for further planning. The Fountain Lake Reservoir has a potential storage capacity of 247,000 acre-feet of which 187,000 acre-feet would be for flood control.

Other potential flood control developments in the Upper Arkansas River basin include the Wolf Creek project and the Horse Creek Reservoir expansion. The Wolf Creek project would be located on Wolf Creek, a tributary of the Arkansas approximately 15 miles southeast of Lamar, Colorado. This potential reservoir would have a total capacity of 30,000 acre-feet of which 27,000 would be reserved for flood control. The Horse Creek project would involve a undetermined expansion of the existing reservoir to provide greater flood control.

Projected Steam-Electric Generating Capacity and Cooling Water Needs

The projected thermal generating capacity and cooling water needs in the Upper Arkansas River are listed in table 6. This data is based on projections from the Second National Water Assessment of the Water Resources Council for steam-electric generating plants with installed capacities of 25,000 kilowatts or more. Projections for the year 1985 indicate a total installed capacity of 4,664,000 kilowatts with a total generation of 20,870 million kilowatt-hours. Many of the older plants will be converted from base-load to a peaking operation. Wells will supply cooling water for only 19 percent of the total generation, primarily through use of wet cooling towers. The estimated 1985 cooling water use is 79 million gallons per day withdrawn and 36 million gallons per day consumed.

The projected total generating capacity in the basin for the year 2000 is 8,033,000 kilowatts. Estimated total generation is 24,190 million kilowatt-hours. For year 2000, cooling water is projected to be 69 million gallons per day withdrawn and 37 million gallons per day consumed. No nuclear generation is projected for the Upper Arkansas basin. River sources will supply cooling water

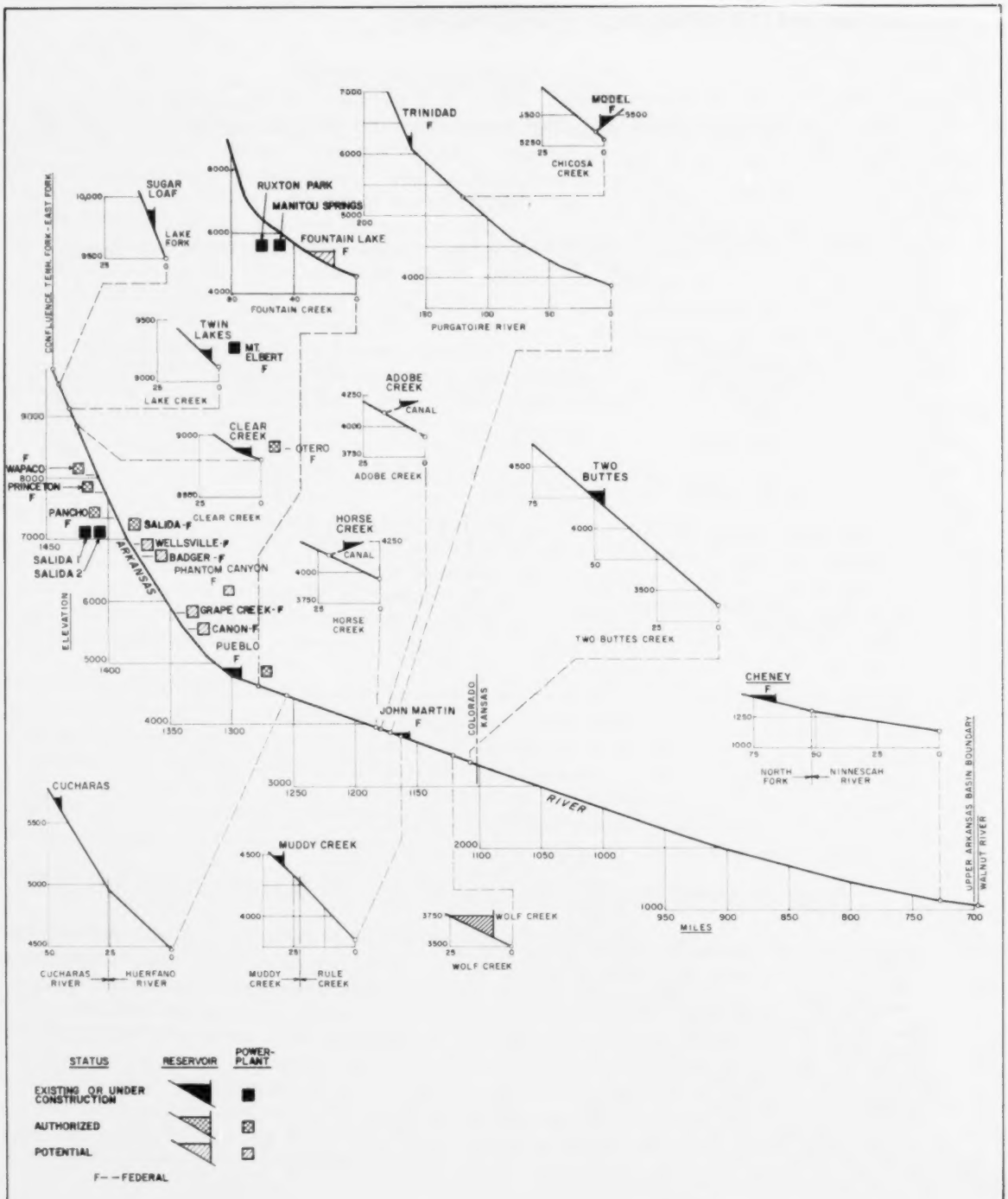
for 71 percent of the generation. About 0.2 percent of the total generation will use once-through cooling. The remainder of the generation will use wet cooling towers.

Table 6

Projected Steam-Electric Generating Facilities and Cooling Water Needs
Upper Arkansas River Basin

Year	Installed Capacity (kW)	Generation (million kWh)	Cooling Water Use	
			Withdrawn (mgd)	Consumed (mgd)
1985	4,664,000	20,870	79	36
2000	8,033,000	24,190	69	37

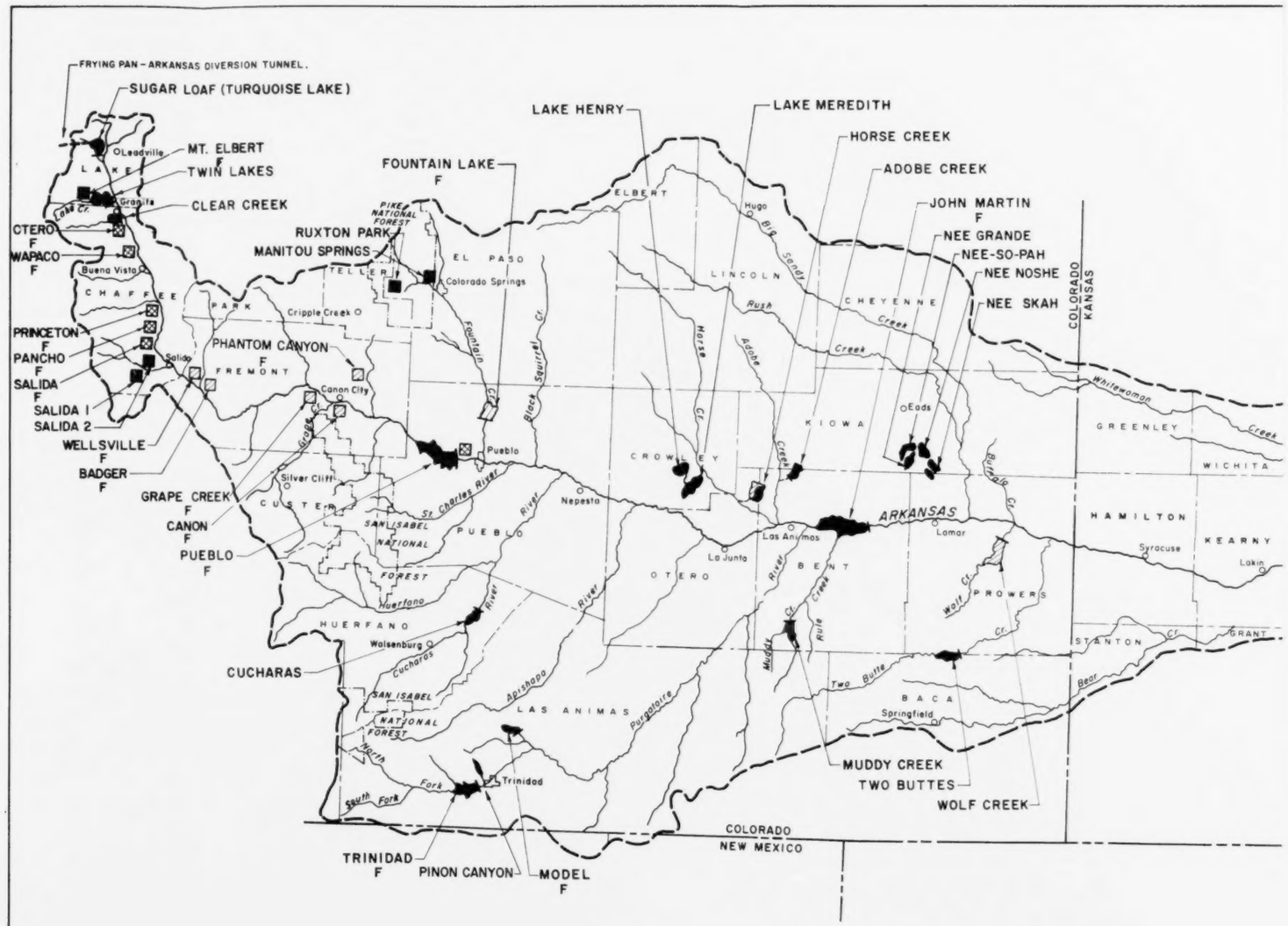
☆U.S. GOVERNMENT PRINTING OFFICE: 1980 O— 329-284/6593



BASIN PROFILE

UPPER ARKANSAS RIVER BASIN
1980

FERC-WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING **Figure 1**



FERC-WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING

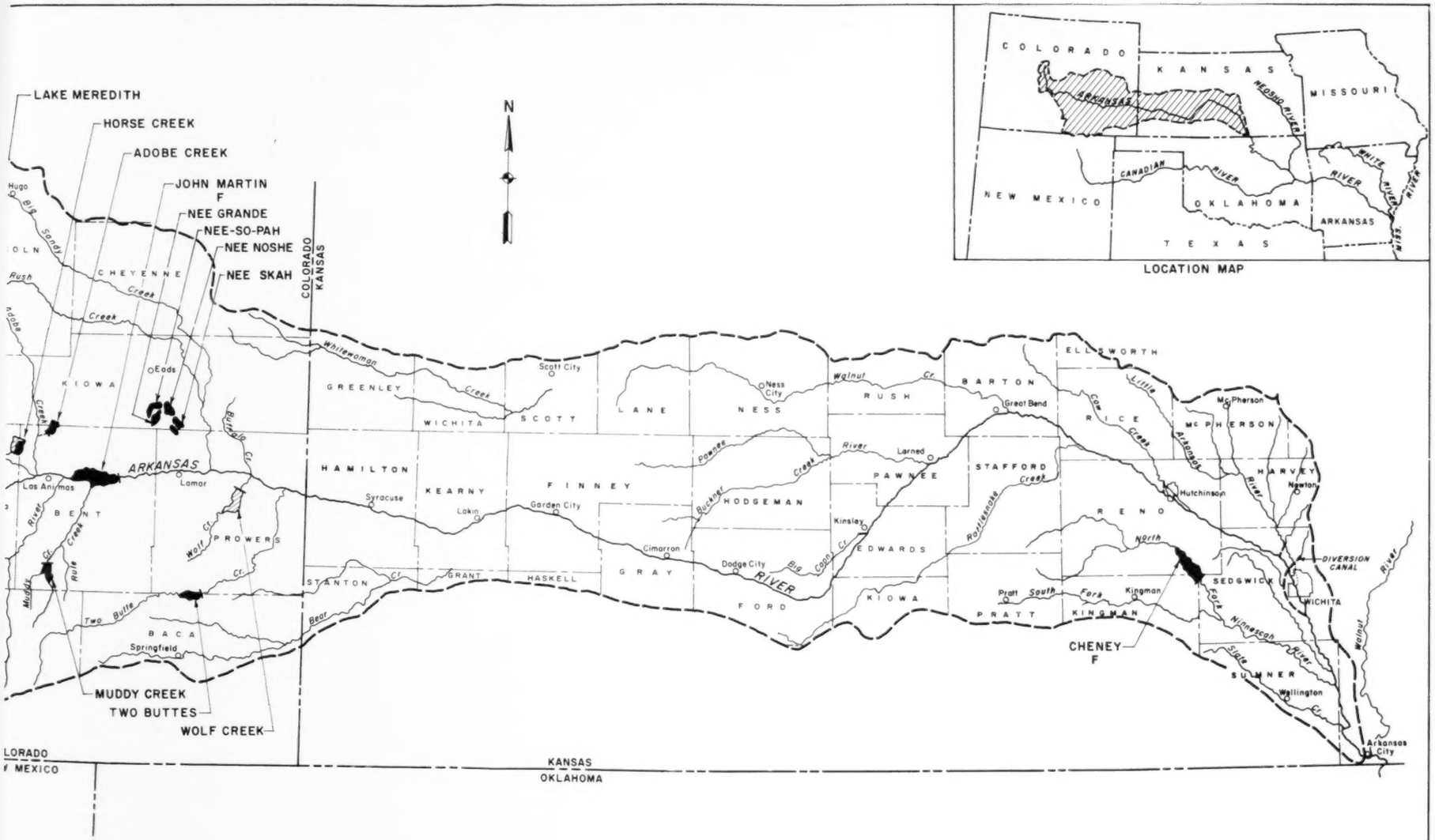

LAKE MEREDITH
HORSE CREEK
ADOBE CREEK
JOHN MARTIN
F
NEE GRANDE
NEE-SO-PAH
NEE NOSHE
NEE SKAH
MUDDY CREEK
TWO BUTTES
WOLF CREEK
CHENEY
F
COLORADO
KANSAS
OKLAHOMA
N
LOCATION MAP
COLORADO
KANSAS
NEBRASKA
MISSOURI
ARKANSAS
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
CANADIAN RIVER
RED RIVER
WHITE RIVER
Hugo
Big Sandy
CHEYENNE
Rush Creek
Adobe Creek
KIOWA
Eads
Arkansas River
Las Animas
Lamar
BENT
PROWERS
Wolf Cr.
Middle Cr.
Rule Creek
Two Butte
BACA
Springfield
Burlingo Cr.
Whitewoman Creek
GREENLEY
Scott City
WICHITA
SCOTT
LANE
Ness City
NESS
HAMILTON
Syracuse
KEARNY
Lakin
FINNEY
Garden City
Cimarron
GRAY
Dodge City
Big Coon Cr.
FORD
STANTON Cr.
GRANT
HASKELL
Bear
Walnut Cr.
RUSH
Larned
Pawnee River
Pawnee Creek
Buckner
HODGEMAN
Kinsley
EDWARDS
KIOWA
Rattlesnake
PAWNEE
STAFFORD
Creek
BARTON
Great Bend
ELLSWORTH
Little Cow Creek
RICE
McPherson
McPHERSON
Arkansas River
HARVEY
Newton
Hutchinson
RENO
North Fork
Pratt
South Fork
Kingman
PRATT
KINGMAN
SEDGWICK
DIVERSION CANAL
WICHITA
Ninnescah River
SUMNER
Wellington
Slate Cr.
Walnut River
Arkansas City
LORADO
MEXICO
KANSAS
OKLAHOMA
LEGEND
STATUS
RESERVOIR
POWER-PLANT
EXISTING OR UNDER CONSTRUCTION
AUTHORIZED
POTENTIAL
F--- FEDERAL
UPPER ARKANSAS RIVER BASIN
1980
8 0 8 16 24
SCALE IN MILES

Figure 2